

Eastern Equine Encephalitis in Quebec and Connecticut, 1972: Introduction by Infected Mosquitoes on the Wind?

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ABSTRACT

In 1972 there were outbreaks of eastern equine encephalitis in the Eastern Townships, Quebec, Canada and in Connecticut, USA. Climatic data including Northern Hemisphere synoptic charts were examined. The findings indicate that the virus could have been brought to Lac Brome by infected mosquitoes carried on surface winds from Meriden, Connecticut, on the night of August 22-23, 1972. The distance of 400 km would have been covered in 14-16 h at a speed of 25-30 kmh⁻¹ and at a temperature of 15°C and higher. The first case was recorded 13 days later on September 5, 1972.

The outbreak at Meriden, Connecticut started on August 21, 1972. On August 7, 1972 southwesterly winds blew along the Atlantic coast at heights up to 1.5 km. Infected mosquitoes could have been carried on the wind from Cape May, New Jersey, Delaware-Maryland-Virginia peninsula, North Carolina or Georgia. Flights would have been at 17°-20°C and lasted 5-6, 9-10, 14-16 and 20-26 h depending on the origin. The arrival on August 8, 1972 coincided with a cold front moving from the northwest through Connecticut. *Culiseta melanura* is regarded as the mosquito species most likely to have been involved in the transmission of infection.

RÉSUMÉ

En 1972, l'encéphalo-myélite équine de l'Est s'est manifestée dans les Cantons de l'Est du Québec, au Canada, et au Connecticut, aux États-

Unis. L'examen des chartes synoptiques des données climatiques relatives à l'hémisphère nord révéla la possibilité du transport du virus jusqu'au lac Brome par des maringouins infectés, charriés par des vents de surface en provenance de Meriden, Connecticut, dans la nuit du 22 au 23 août 1972. La distance de 400 km, entre ces deux endroits, aurait été franchie en 14 à 16 heures, à la vitesse de 25 à 30 km/h et à la température de 15°C et plus. On enregistra le premier cas de la maladie, 13 jours plus tard, le 5 septembre 1972.

L'éclosion de l'infection, à Meriden, Connecticut, se manifesta le 21 août 1972. Quatorze jours plus tôt, des vents du sud-ouest avaient soufflé le long de la côte Atlantique, à des hauteurs qui atteignirent jusqu'à 1,5 km. Il est possible que des maringouins infectés aient été charriés par le vent, de Cap May, New Jersey, de la péninsule Delaware-Maryland-Virginie, de la Caroline du Nord ou de la Georgie. Ces vols se seraient produits à des températures variant de 17 à 20°C et durèrent respectivement de cinq à six, de neuf à dix, de 14 à 16 et de 20 à 24 heures, selon leur lieu d'origine. L'arrivée des maringouins, le 8 août 1972, coïncida avec un front froid qui se déplaçait du nord-ouest, à travers le Connecticut. On considère *Culiseta melanura* comme l'espèce de maringouin la plus susceptible d'avoir été impliquée dans la transmission de l'infection.

INTRODUCTION

In September and October 1972 eastern equine encephalitis (EEE) was diagnosed in horses in the Eastern

Townships of Quebec, Canada, around Lac Brome (1,2). Thirty horses died of the disease, which disappeared after the first frost. The origin of these outbreaks is obscure. The EEE virus might have been endemic in the area in avian hosts or the virus might have been introduced by infected birds from elsewhere. Another possibility is that the virus was introduced by mosquitoes carried on the wind. The last possibility is examined in this paper, especially in connection with an outbreak that occurred in August 1972 in Connecticut, USA.

In Canada a previous outbreak of EEE in horses was recorded at St. George, Ontario in 1938. The EEE virus was isolated from blood of a migrating bird at Long Point, Ontario and from two snowshoe hares in Alberta. Antibodies to EEE virus were found in migrating birds in Ontario, in snowshoe hares, ruffed grouse and pronghorns in Alberta and Saskatchewan (3).

In USA EEE disease in horses and humans occurs at intervals in states along the Atlantic seaboard and inland in Michigan and northern New York State (4). From 1970 to 1984 EEE outbreaks were recorded in Michigan, New York, Connecticut, Rhode Island, Massachusetts and New Jersey as well as in states along the Atlantic Seaboard. Antibodies to EEE virus were found in South Dakota and Wisconsin (5).

The first case of EEE in Quebec in 1972 was reported on September 5 at Iron Hill, NW of Lac Brome, and the last near Foster, NE of Lac Brome, on October 6, 1972 (1) (Fig. 1). Other

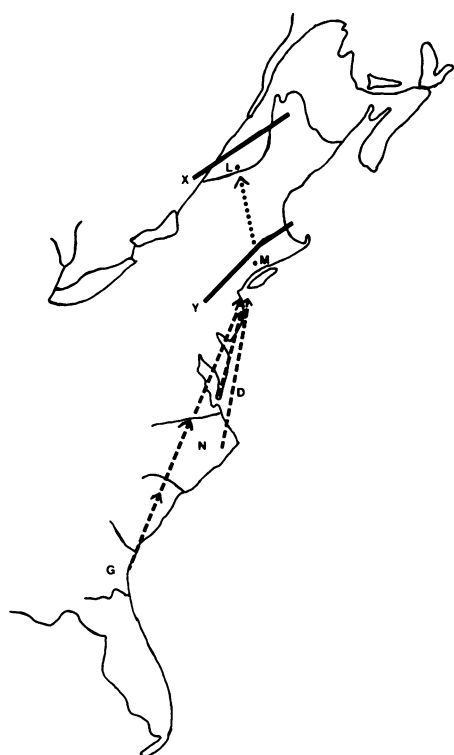


Fig. 1. Location map showing outbreaks of EEE at Meriden, Connecticut and Lac Brome, Quebec, August and September 1972.

- > Wind directions (850 mb) August 7-8, 1972.
-> Wind directions (surface) August 22-23, 1972.
- Position of front:
- X 0100 EST. August 23, 1972.
- Y 0100 EST. August 8, 1972.
- G — Georgia, N — North Carolina, D — Delaware-Maryland-Virginia peninsula, M — Meriden, L — Lac Brome.
- Cape May County is the next cape north of the Delaware-Maryland-Virginia peninsula.

cases occurred around Lac Brome between these dates and in all 30 horses died. The EEE virus was isolated from the brains of five horses which had showed encephalitis before death (2).

An epidemic of EEE occurred in Connecticut in 1972 (6) (Fig. 1). Birds (pheasants, chukars, wild and domestic turkeys, quail and doves) were affected as well as horses. The EEE virus was isolated from pheasants and other birds and from nine horses. The first outbreak was on August 21, 1972 in Meriden and the last on October 24, 1972 at Danielson. Mortality was as high as 70-75% in pheasant flocks. The epidemic was mainly in the Connecticut and Thames River valleys.

The EEE virus was isolated from *Culiseta melanura* mosquitoes collected in late September and October 1972 at Farmington, Connecticut (7).

There was a case of EEE in a horse in Oswego County, New York on September 30, 1972 (8).

Thirty cases of EEE in horses confirmed by laboratory diagnosis were recorded for USA in 1972 (9).

MATERIALS AND METHODS

The incubation period of EEE in horses varies from 3-15 days (4,10). Viraemia in horses and in birds is found from the first to the fifth day. Titers in bird blood are sufficient to infect mosquitoes, but this is not always the case with viraemia in horses.

The mosquitoes responsible for transmitting EEE virus may be able to transmit EEE virus from seven to eight days after a blood meal to the end of their lives (11). As they take a blood meal every three to four days, or longer, transmission could occur from the second blood meal onwards.

Maximum and minimum temperatures, rainfall (precipitation), wind direction and speed were obtained from the Monthly Record and from the surface and 850 millibar (mb) Northern Hemisphere maps of the Canadian Climate Centre. The periods chosen for the Canadian outbreak were from August 21, 1972 to September 1, 1972 and for the outbreak in Connecticut from August 6, 1972 to August 17, 1972.

RESULTS

OUTBREAK AROUND LAC BROME

The records show that from August 21 to September 1, 1982 maximum daily temperatures at Brome were between 22° and 31°C and apart from August 21 minimum temperatures were between 15°C and 21°C. Rain was recorded on August 23, 25, 27 and 28, 148 mm falling on August 23, 1972. The surface maps indicate a front situated north of Lac Brome along latitude 46°N on August 22 and 23, 1972.

On the night of August 22-23, 1972 the surface maps show southerly winds blowing northwards along the Connecticut River valley. It is suggested that

mosquitoes infected with EEE virus were carried on the wind from the region around Meriden to Lac Brome. The mosquitoes would have covered the distance of about 400 km in 14-16 h at a speed of 23-30 kmh⁻¹ at a temperature of 15°C and higher. Landing near Lac Brome would have taken place on the 23rd August with the arrival of the front and rain. Eastern equine encephalitis was first seen in horses on September 5; this would indicate an interval of 13 days after the arrival of the insects (Fig. 1).

Minimum temperatures of -5°C and -3°C were recorded on September 23 and September 28, 1972 respectively. The last cases were observed on October 5 and 6, 1972, 12 and 13 days after the first spell of cold weather.

OUTBREAK IN CONNECTICUT

The Northern Hemisphere 850 mb charts for August 7, 1972 show southwesterly winds blowing along the Atlantic Coast states. On August 8, 1972 the surface maps show that a cold front moved from the northwest through Connecticut. Thus mosquitoes infected with EEE virus could have been carried on the southwest winds landing on the morning of August 8 about the time the cold front was passing. The mosquitoes would have travelled up to a height of 1.5 km at wind speeds of 50-60 kmh⁻¹ and at temperatures of 17°-20°C. Depending on flight duration, their origin could have been Cape May County, New Jersey (300 km-time 5-6 h), the Delaware-Maryland-Virginia peninsula (500 km-time 9-10 h), North Carolina (800 km-time 14-16 h) and Georgia (1200 km-time 20-24 h) (Fig. 1). All these origins are places where EEE is regarded as endemic and virus has been isolated from mosquitoes and birds (5). A flight time of up to 24 h can be regarded as the length of endurance for a mosquito (12). The interval between the time of arrival of August 8, 1972 and the first case recorded in pheasants on August 21, 1972 was 13 days.

DISCUSSION

Analysis of temperature, wind direction and speed, precipitation and movement of cold fronts indicates the possible route by which infected

mosquitoes carried on the wind could have introduced EEE virus to Connecticut, USA and Quebec, Canada in 1972.

Five species of mosquitoes have been implicated in transmission of EEE virus (5,13). *Culiseta melanura* is considered to be the main vector and is found in Connecticut and Quebec as well as in states along the Eastern Seaboard and in states east and west of the Mississippi river (14,15,17). It feeds mainly on passerine birds, but later in the year will bite nonpasserine birds and mammals (18). Its main habitat is near swamps but it has been caught in open land away from the swamps and collected 13 km from land over Delaware Bay (19-22). In the northern areas it overwinters as larva, but further south breeding is continual, although at a slower rate, during the colder months (17,23). The EEE virus has been isolated most often from *Cs. melanura* (24,25).

Of the other four species (*Aedes canadensis*, *Aedes sollicitans*, *Aedes vexans* and *Coquillettidia perturbans*). *Aedes sollicitans* has not been found in Quebec (26). The other species prefer to feed on mammals but occasionally bite birds (18). *Aedes* species overwinter as eggs and *Cq. perturbans* as larvae (5). *Aedes vexans* is carried long distances on the wind (12). It is believed that these species of mosquitoes amplify infection with the EEE virus, once the virus cycle has started in birds and *Cs. melanura* (5).

It is therefore suggested that the introduction to Connecticut was through *Cs. melanura*, which then began to bite nonpasserine birds and horses. *Culiseta melanura* was the most numerous mosquito in Connecticut in 1972 (7,14). Introduction could also have been through *Cq. perturbans*, *Ae. canadensis* and *Ae. vexans*. All four species of mosquito could have introduced EEE virus to Quebec.

The EEE virus has so far not been shown to overwinter in *Cs. melanura* larvae (25,27). In Georgia, a possible source for the outbreaks in Connecticut and Quebec, adult *Cs. melanura* mosquitoes are found throughout the year and it may be that EEE virus continues to cycle in these mosquitoes during the northern winter months (28). In the spring and early summer

infected mosquitoes could be carried further north in stages, the places where they land depending on where warm southerly winds meet cold fronts.

It has also been suggested that EEE virus could be introduced by birds coming from the tropics (29). In upstate New York the spring migration by birds is over by the beginning of June and the southward migration starts at the end of July and continues to late October (30). Southward migrants in the fall would have been coming to Quebec from areas where EEE virus has not been reported. If northbound migrants in the spring to Connecticut had introduced EEE virus, the virus from such introduction would have to have circulated silently in local mosquitoes and birds until the outbreak in pheasants in August.

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